

NOTES ON THE GENUS LEPOMIS.

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This group of fresh-water sunfishes has been variously divided by different authors. It has been separated into at least eleven nominal genera, distinguished mainly by the presence or absence of a supplemental maxillary and by the shape of the lower pharyngeal bones, the character of their teeth, the length and shape of the pectoral fin, and the presence or absence of a red spot on the opercular flap. Two of the later authors who have worked on this subject, McKay¹ and Bollman² decided that they should be included under one generic name, *Lepomis*, and that the others are not tenable. On the other hand, Forbes and Richardson³ decided that the species must be divided between the genera *Lepomis* Rafinesque and *Eupomotis* Gill and Jordan, and after a careful examination of a considerable series of pharyngeal bones and teeth we were inclined to agree with the latter. An examination of the pharyngeal bones of the type-specimens of *Lepomis euryorus* McKay and of *Bryttus albulus* Girard, however, makes it evident that these two nominal genera are not separable, as these specimens show a complete intergradation between the characters of the two.

The character of the presence or absence of a supplemental maxillary has no value, as this bone is present or absent in individuals of the same species, and, when present, the size is extremely variable in fishes of the same species from the same locality. (See pls. 42 and 43.)

In the typical *Eupomotis* the pharyngeal bones are broad, and the teeth are large and blunt. This character is subject to much variation. In the two specimens of *Lepomis holbrookii* illustrated, obtained in the Center Market in Washington, which are presumably from the same general locality (North or South Carolina),

¹ Proc. U. S. Nat. Mus., vol. 4, 1881, p. 88.

² Rept. U. S. Fish Comm., 1888 [1892], pp. 557-580.

³ Bull. Illinois State Lab. Nat. Hist., vol. 7, pp. 27-32, published in 1904.

and show no other important differences, there is considerable variation in the width of the bones, in their relative thickness, and in the size and arrangement of the teeth. In the two specimens illustrated, which were identified as *Lepomis heros*, but which do not agree very closely with the type, especially in depth of body, this difference is even more marked. These two specimens were from the same section of Indiana and showed no variations except those due to slight difference of age. In both of these species the pharyngeal bones are much heavier than in *Lepomis gibbosus*, which, however, has the largest and bluntest teeth of the group. In the type of *Lepomis heros* the pharyngeal teeth and bones are much more like those of *Lepomis gibbosus* than are those in the Indiana specimens. The main characters given by Forbes and Richardson for the separation of these two groups are not so much the size of the teeth but more especially the shape of the outer edge and lower surface of the pharyngeal bones. In *Lepomis* this edge is straight, while in *Eupomotis* it has more or less of a sigmoid curve. In *Lepomis* the lower surface of the bone is straight or concave, while in *Eupomotis* it is more or less convex, and the bone is usually much heavier. In both of these characters *Bryttus albulus* and *Lepomis euryorus* are intermediate, as they are in size and bluntness of the teeth.

Small specimens of *Lepomis gibbosus* and *Lepomis pallidus*¹ when taken from the same waters can not be distinguished, unless they are large enough to show the adult coloration. In order to determine whether the character of the form of the pharyngeal bones was likewise difficult of application to young individuals, we examined several small *Lepomis gibbosus* obtained for us at Ithaca, New York, where this species alone is found, and compared their pharyngeal bones with those of young of both species taken in Sodus Bay, Wayne County, New York. The specimens used for comparison were about 1 inch (2½ cm.) long, and it was necessary to use a compound microscope in examining the pharyngeals. It was found that although the bones were narrower in young *Lepomis gibbosus* than in adults, nevertheless they were broader than in *Lepomis pallidus* of the same size and that the teeth in *Lepomis gibbosus* were much heavier.

The pharyngeal bones and teeth are similar in form and structure in *Xystroplites gillii* Jordan and *Bryttus albulus* Girard, but there are slight differences in the size of the scales and in proportional measurements which have caused us to leave them for the present under separate specific names, *Lepomis gillii* (Jordan) and *Lepomis albulus* (Girard) until an examination of a long series of specimens shall show whether they are or are not distinct species. The pharyn-

¹ We are unable to satisfy ourselves of the exact status of the name *pallidus* and retain it in accordance with current usage until a proper decision can be reached.

geal bones and teeth of the type of *Calliurus murinus* Girard are much heavier than those of *Lepomis cyanellus*. They more closely resemble *Lepomis euryorus* McKay.

We do not have the material available to determine the status of *Pomotis pallidus* Agassiz which has been assigned to the genus *Eupomotis* by Jordan and Evermann.

Lepomis cyanellus, the type of the genus *Apomotis* has the pharyngeal bones thinner and lighter than in any of the other sunfishes examined. The teeth, however, are heavier than in some other species. (See pl. 50.)

Lepomis auritus, the type of the genus *Lepomis*, has the pharyngeal bone heavier than in *Lepomis cyanellus*, with the teeth about the same. (See pl. 48.)

Lepomis pallidus has the pharyngeal bone rather lighter than in *Lepomis auritus*, but heavier than in *Lepomis cyanellus*. The teeth, however, are finer than those of any other species which we have examined. (See pl. 49.)

In *Lepomis megalotis* the pharyngeal bones are similar to those of *Lepomis pallidus* and the teeth are somewhat heavier. (See pl. 50.)

Lepomis albulus has the pharyngeal bone about as heavy as in *Lepomis auritus* but the teeth considerably thicker and blunter. (See pl. 48.)

Lepomis euryorus has the pharyngeal teeth about as in *Lepomis albulus*, but the bone is heavier and broader and begins to show the condition which Richardson describes for *Eupomotis*. (See pl. 47.)

Lepomis holbrookii has the pharyngeal bone very heavy and the teeth quite variable, but usually half of them, or a little less than half, round molars. (See pls. 42 and 43.) (Note variations in supplemental maxillary.)

The teeth of the type specimen of *Lepomis heros* are large molars over practically the entire surface of the bone, which is broad but not especially thick, much as in *Lepomis gibbosus*. Two specimens from Indiana, labeled as this species, had the bones very broad and thick as in *Lepomis holbrookii*, but with a larger proportion of molar teeth. (See pls. 44, 45, and 47.)

Lepomis gibbosus, the type of the genus *Eupomotis* of Gill and Jordan, has the pharyngeal bone very broad with very large molar teeth. The bone, however, is rather thin as compared with that of *Lepomis holbrookii*. (See pl. 46.)

The genus *Lepomis* seems to us to be most certainly a natural group. The species are so similar in squamation, coloring, number of fin rays, and proportions that with a few well-marked exceptions, perhaps only one exception (*Lepomis gibbosus*), it requires much experience and long study to separate species. Adult specimens of

Lepomis gibbosus in bright color can be almost always identified at sight, but this can not be said of the others.

Below we give a list of some of the prominent writers who have treated more or less at length of the sunfishes:

C. S. Rafinesque¹ did not mention pharyngeal teeth in his diagnoses of the genera *Lepomis*, *Pomotis*, and *Apomotis*. Later (1819–1821) the same author² proposed the names *Calliurus*, *Ichthelis* (= *Lepomis*), and *Telipomis* (= *Apomotis*) giving various unimportant characters in his diagnoses, but making no mention of pharyngeal bones or teeth or any other structural distinctions.

Cuvier and Valenciennes³ gave paved pharyngeal teeth as one of the principal characters of the genus *Pomotis*. In a revision of the generic characters in the seventh volume (1831) this is not mentioned and is evidently not considered.

J. P. Kirtland, in his notes on fishes of the Ohio River,⁴ does not mention pharyngeal bones in the descriptions.

Charles Girard did not use this character in his diagnoses of several genera of *Centrarchidæ* in *Fishes of the Pacific Railroad Survey* (1858) and *Fishes of the Mexican Boundary Survey* (1859).

John Edwards Holbrook in the *Ichthyology of South Carolina* (1860) defines the genus *Pomotis* (= *Eupomotis* Gill and Jordan) on page 7, and *Ichthelis* (= *Lepomis* Rafinesque), page 12. He seems to have been the first author to have used the character of the pharyngeal teeth as the major difference between groups of sunfishes. We quote his diagnosis in full:

GENUS POMOTIS.—*Rafinesque*.

CHARACTERS: Pre-opercle more or less denticulated; opercle with a membranous appendix at its angle; intermaxillary, vomerine, and inferior maxillary teeth villiform; tongue and palate bones smooth, or without teeth; pharyngeal teeth paved; dorsal fin single; anal with three spines; branchiostegal rays, six.

GENUS ICHTHELIS.—*Rafinesque*.

CHARACTERS: Body elliptical or oval, much more compressed; mouth small, armed with small teeth; *pharyngeal teeth not paved*; branchiostegal rays, six.

This is a change from the first edition (1855) where all the species are grouped in the genus *Pomotis*, which is thus defined on page 6:

Pre-opercle more or less denticulated; intermaxillary, vomerine, inferior maxillary, and pharyngeal teeth; tongue and palate bones smooth or without teeth, a membranous appendix at the angle of the opercle; branchial rays, six.

David Humphreys Storer⁵ mentions minute teeth on pharyngeal as one of the characters of *Pomotis*, but gives it no special consideration.

David Starr Jordan⁶ proposes the name *Lepiopomus* as a better

¹ Journ. de Physique, 1819, pp. 402–420.

² Ichthyologia Ohiensis, pp. 26, 27.

³ Hist. Nat. Poiss., vol. 3, 1829, p. 91.

⁴ Boston Journ. Nat. Hist., vols. 3, 4, 5, 1840 to 1845.

⁵ Fishes of Massachusetts, 1867, p. 12.

⁶ Ann. N. Y. Lyc. Nat. Hist., 1876, p. 316.

spelling for *Lepomis*. On page 355 of the same publication he proposes the name *Helioperca* as a generic designation for *Lepomis pallidus*.

Gill and Jordan¹ propose the name *Eupomotis* for the genus typified by the common sunfish *Eupomotis gibbosus*, no diagnosis being given, but the synonymy of this species in full as then understood. In the same year David Starr Jordan² amplifies the statement of reasons for offering a new name, but gives no generic diagnosis. He adds two species to the list of those in the new genus.

Early in 1877 Doctor Jordan³ proposed the name *Xenotis* for species of *Lepomis* with the gill rakers on the first arch especially short and weak. No mention is made of the pharyngeal bones and the generic characters given are not distinctive.

On May 20, 1877, Edward D. Cope read before the American Philosophical Society a paper⁴ in which he described *Xystroplites longimanus* as a new genus and species from two localities in Florida.

About the same time Doctor Jordan⁵ described *Xystroplites gillii* as a new genus and species, giving Garden Key, Florida, as the locality from which the specimen was received. This is obviously an error and we have no means now of knowing the type-locality of this species. Professor Cope says in his description that Doctor Jordan's description was written first and, he supposes, was published first.

The two generic diagnoses are somewhat at variance in describing the pharyngeal teeth. We quote both:

The pharyngeal bones themselves are much narrower and smaller than in *Eupomotis*, being in form more like those of *Xenotis*. The teeth are less strongly "paved," being smaller, less crowded, and rounded rather than truncate; on the inner border of the bone are a few enlarged acute teeth. (Bull. 10, U. S. Nat. Mus., p. 24.)

Inferior pharyngeal bones wide and robust, and paved with truncate grinding teeth. (Proc. Amer. Phil. Soc., vol. 17, 1877-78, p. 67.)

Charles L. McKay⁶ says of the genus *Lepomis*:

This genus, as understood by me, includes *Apomotis*, *Xenotis*, *Bryttus*, *Helioperca*, *Xystroplites*, and *Eupomotis* of authors. *Apomotis* has been separated from *Lepomis* on account of the large size of the supplemental maxillary. On careful comparison this is found to be scarcely larger than in one or two other species of *Lepomis*. It disappears by degrees, but seems to exist in all the species, though sometimes so small as to be inappreciable. I have even found it present in large specimens of *L. pallidus*. Its presence in the species is only a character of degree, therefore not generic. Till the group had been more carefully studied, *Xenotis* was supposed to contain a large number of species, and was separated from *Lepomis* principally for convenience sake and on the slight character of the feeble gill rakers. By a comparison of a very large series of the alleged species from Professor Jordan's collection, I have come to the conclusion that they are all forms of a single species. The gill rakers are usually rather more feeble than in the rest of the species of *Lepomis*, but this again is a question of degree. *Bryttus* has been distinguished from *Lepomis* by the presence of palatine teeth. This

¹ Field and Forest, May, 1877, p. 190.

² Bull. 10, U. S. Nat. Mus., 1877.

³ Proc. Acad. Nat. Sci., Phila., 1877, p. 76.

⁴ Proc. Amer. Philos. Soc., vol. 17, pp. 63 to 68.

⁵ Bull. 10, U. S. Nat. Mus., 1877, p. 24.

⁶ Proc. U. S. Nat. Mus., vol. 4, 1881, June 2.

is also a character of degree, and is subject to the most perfect gradation. I have found it impossible to retain *Xystroplites* and *Eupomotis* also, as there is complete gradation in the character of the pharyngeals between *Lepomis* proper and *Xystroplites*, and again between *Xystroplites* and *Eupomotis* both as to the width and form of the bones themselves and the form of the teeth.

Jordan and Gilbert¹ include all the species in the single genus *Lepomis*, giving as one of the characters "lower pharyngeals narrow, the teeth conic or paved." That this will not hold true of all species may be seen from an examination of the accompanying illustrations.

Charles Harvey Bollman, in A Review of the *Centrarchidæ*,² places all the species under one generic name, *Lepomis*.

Boulenger³ separates the genera *Apomotis*, *Lepomis*, and *Eupomotis* on the characters of the supplemental maxillary and of the form of the pectoral fin. He does not mention the pharyngeal bones or teeth.

Jordan and Evermann⁴ base the genera *Apomotis*, *Lepomis*, and *Eupomotis* on the characters of the pharyngeal teeth and the supplemental maxillary. Under the genus *Lepomis*, page 999, they say: "* * * lower pharyngeals narrow, the teeth spherical or paved, all or nearly all sharp, few or none conical." This does not hold true of *Lepomis pallidus* or *Lepomis megalotis*.

Tarleton H. Bean⁵ follows Jordan and Evermann⁶ in assigning characters to the three genera.

Robert Earl Richardson⁷ disagrees with the findings of McKay and of Bollman and makes two genera, *Lepomis* and *Eupomotis*, on the character of the pharyngeal teeth. He examined the bones and teeth of many specimens of about fifteen species. His conclusions were justified by the material used and it was largely by accident that we found the intermediate conditions.

Henry W. Fowler⁸ mentions the pharyngeal teeth in the key to the genera of *Centrarchidæ*, where he used the same terms descriptive of the shape of teeth and bones as are used by Jordan and Evermann⁹. In the description of *Lepomis phenax* (p. 290) and of *Eupomotis gibbosus* (p. 295) the pharyngeal bones and teeth are briefly described.

Hugh M. Smith¹⁰ includes all the species mentioned under the genus *Lepomis*, giving the following diagnosis on page 239:

Body ovate, compressed, the dorsal outline in adults rather more strongly arched than the ventral; mouth of moderate size, jaws equal, maxillary narrow and not extending beyond pupil, supplemental bone small or wanting; no teeth on tongue

¹ Bull. 16, U. S. Nat. Mus., 1882, p. 472.

² Report U. S. Fish Commission for 1888 (1892), p. 565.

³ Catalogue of Fishes in the British Museum, ed. 2, vol. 1, p. 6.

⁴ Bull. 47, U. S. Nat. Mus., vol. 1, 1896.

⁵ Fishes of New York, 1903, pp. 475, 477, 482.

⁶ Bull. 47, U. S. Nat. Mus.

⁷ Bull. Ill. State Lab. Nat. Hist., vol. 7, March, 1904, p. 27.

⁸ Fishes of New Jersey, 1905, p. 728.

⁹ Bull. 47, U. S. Nat. Mus.

¹⁰ Fishes of North Carolina, 1907.

or pterygoids; pharyngeal bones narrow or broad, with sharp or blunt paved teeth; preopercular margin entire; opercle ending in a more or less elongated flap which is conspicuously colored; gill rakers usually short and feeble; dorsal spines, 10; anal spines, 3; caudal fin concave or emarginate behind; pectorals long or short, pointed or rounded.

Forbes and Richardson¹ say:

The genus *Lepomis*, as here understood, includes *Apomotis* of various authors. The forms that have been known under these two names agree in their pharyngeal dentition, which is remarkably different from that of the genus *Eupomotis*. The fact that the opercular flap is usually either entirely black or black with a definite border above, behind, and below serves as a useful distinction of the species of this genus from the single commonly distributed species of *Eupomotis* (*E. gibbosus*), in which there is always a conspicuous roundish spot of red at the lower posterior corner of the opercular flap.

In a footnote on the same page they add:

We have not found the "complete gradation in the character of pharyngeals between *Lepomis* * * * and *Eupomotis*, both as to the width and form of the bones themselves and the form of the teeth" that was described by McKay (Proc. U. S. Nat. Mus., vol. 4, 1881, p. 88). (See Richardson, 1904, Bull. Ill. State Lab. Nat. Hist., vol. 7, pp. 27-32.)

Also on page 259 under genus *Eupomotis*:

Form as in *Lepomis*; mouth always small; no supplemental maxillary bone and no teeth on palatines; lower pharyngeals deep and broad, with inferior and lateral prominences, the width of the toothed portion about 2 in its length; pharyngeal teeth short with the upper surfaces bluntly rounded or paved (truncate); gill-rakers short; fins rather long; red color on opercular flap in typical species forming a roundish spot. Eastern United States and Canada; 3 species.

Meek and Hildebrand² adopt the generic diagnosis of Forbes and Richardson.

EXPLANATION OF PLATES.

PLATE 42.

- Fig. 1. Left side of left lower pharyngeal of *Lepomis holbrookii*, Cat. No. 66310, U.S.N.M., South Carolina (?). $\times 6$ diameters. Fish 25 cm. long.
 2. Dorsal aspect of left lower pharyngeal of same. $\times 6$ diameters.
 3. Right maxillary of same showing supplemental bone. $\times 6$ diameters.

PLATE 43.

- Fig. 1. Left side of left lower pharyngeal of *Lepomis holbrookii*, Cat. No. 66311, U.S.N.M., South Carolina (?). $\times 6$ diameters. Fish 20.4 cm. long.
 2. Dorsal aspect of left lower pharyngeal of same. $\times 6$ diameters.
 3. Right maxillary of same, supplemental bone absent. $\times 6$ diameters.

PLATE 44.

- Fig. 1. Left side of left lower pharyngeal of *Lepomis heros*, Cat. No. 65185, U.S.N.M., Lake Maxinkuckee, Indiana. $\times 6$ diameters. Fish 17.4 cm. long.
 2. Dorsal aspect of left lower pharyngeal of same. $\times 6$ diameters.
 3. Right maxillary of same, no supplemental bone. $\times 6$ diameters.

¹ Fishes of Illinois, 1907, p. 247.

² Fishes Known to Occur Within Fifty Miles of Chicago, Field Mus., Zool. Ser., vol. 7, No. 9, April, 1910, pp. 311 and 314.

PLATE 45.

- Fig. 1. Left side of lower pharyngeal of *Lepomis heros*, Cat. No. 65192, U.S.N.M., Lost Lake, Indiana. $\times 6$ diameters. Fish 22.2 cm. long.
2. Dorsal aspect of left lower pharyngeal of same. $\times 6$ diameters.

PLATE 46.

- Fig. 1. Left side of left lower pharyngeal of *Lepomis gibbosus* from Washington, District of Columbia. $\times 6$ diameters. Fish about 15 cm. long.
2. Dorsal aspect of left lower pharyngeal of same. $\times 6$ diameters.
3. Right maxillary of same, no supplemental bone. $\times 6$ diameters.
4. Upper pharyngeal of *Lepomis heros*, Cat. No. 65185, U.S.N.M., from Lake Maxinkuckee, Indiana. $\times 6$ diameters.
5. Upper pharyngeal of *Lepomis holbrookii*, Cat. No. 66310, U.S.N.M., from South Carolina (?). $\times 6$ diameters.

PLATE 47.

- Fig. 1. Left side of left lower pharyngeal of *Lepomis heros*, from type of *Pomotis heros* Girard, Cat. No. 438, U.S.N.M., Texas. $\times 6$ diameters. Fish 18.5 cm. long.
2. Dorsal aspect of left lower pharyngeal of same. $\times 6$ diameters.
3. Left side of left lower pharyngeal of type of *Lepomis euryorus* McKay, Cat. No. 4109, U.S.N.M., Lake Huron. $\times 6$ diameters. Fish 17.5 cm. long.
4. Dorsal aspect of left lower pharyngeal of same. $\times 6$ diameters.

PLATE 48.

- Fig. 1. Left side of left lower pharyngeal of *Lepomis albulus*, from type of *Bryttus albulus* Girard, Cat. No. 421, U.S.N.M., Texas. $\times 6$ diameters. Fish 15.5 cm. long.
2. Dorsal aspect of left lower pharyngeal of same. $\times 6$ diameters.
3. Left side of left lower pharyngeal of *Lepomis auritus*, Cat. No. 44139, U.S.N.M., Laurel, Maryland. $\times 6$ diameters. Fish 15.5 cm. long.
4. Dorsal aspect of left lower pharyngeal of same. $\times 6$ diameters.

PLATE 49.

- Fig. 1. Left side of left lower pharyngeal of *Lepomis pallidus*, Cat. No. 66312, U.S.N.M., South Carolina (?). $\times 6$ diameters. Fish 21.6 cm. long.
2. Dorsal aspect of left lower pharyngeal of same. $\times 6$ diameters.
3. Right maxillary of same, no supplemental bone. $\times 6$ diameters.
4. Left side of lower pharyngeal of *Lepomis pallidus*, Cat. No. 64234, U.S.N.M., Sodus Bay, Wayne County, New York. $\times 6$ diameters.
5. Dorsal aspect of left lower pharyngeal of same. $\times 6$ diameters.

PLATE 50.

- Fig. 1. Left side of left lower pharyngeal of *Lepomis megalotis* from Tippecanoe River, Marshland, Indiana. $\times 6$ diameters. Fish 11.9 cm. long.
2. Dorsal aspect of left lower pharyngeal of same. $\times 6$ diameters.
3. Right maxillary of same, showing supplemental bone. $\times 6$ diameters.
4. Left side of left lower pharyngeal of *Lepomis cyanelus*, Cat. No. 64372, U.S.N.M., Washington, District of Columbia. Fish 14.1 cm. long.
5. Dorsal aspect of left lower pharyngeal of same. $\times 6$ diameters.
6. Right maxillary of same, supplemental bone present. $\times 6$ diameters.